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(54) IMPROVEMENTS RELATING TO DATA TRANSMISSION

(71) We, MULLARD LIMITED, of Abacus House, 33 Gutter Lane, London, EC2V 8AH, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to television transmission systems and particularly to such a system which is adapted to transmit additional data within a normal television video signal.

It is already known to transmit additional data within a broadcast television video signal by using digitally coded signals, representing the additional data, which are inserted into the television video signal for transmission in television lines that occur during the blanking interval between successive television frames where no normal frame information is present. For instance, in the experimental BBC—CEEFAX (Registered Trade Mark) system, the transmission of additional data is effected in lines 13 and 14 on even fields and the adjacent lines 326 and 327 on odd fields of the 625 line broadcast television system used in the United Kingdom. (B.B.C. Research Department Technical Memorandum No. PH—1106 and "Electronics and Power", 12 July, 1973 pp 274—276, "A broadcast information service".).

The use of the blanking interval between successive television frames for transmitting data other than normal frame information is also known from Applicants' U.K. Patent No. 1,147,604 which relates to a television system in which signals which identify frames of information are transmitted during this blanking interval.

When using the blanking interval between successive television frames for the transmission of additional data, only a short period is available in each frame for this purpose, so that the bit rate at which the data is transmitted must be high if a reasonable amount of additional data is to be transmitted. Typically, a bit rate of 4.5 M. bits/sec. during one television line would result in an average data bit rate of 10.7 K. bits/sec. For decoding the transmitted additional data at a television receiver, there must be generated at the receiver a local clock waveform which effects synchronisation of the incoming data bits with the operation of decoding circuitry. Experiment has shown that such synchronisation, which must be accurate in order to obtain substantially error-free decoding, may not readily be achieved with simple circuitry, especially when reception is poor.

It is also known, for instance from U.S.A. specifications Nos. 2,686,220; 3,046,331; 3,676,862; 3,726,992 and 3,666,888; to transmit additional data within the line blanking intervals of a television video signal, that is, blanking intervals that occur in the video signal between normal line information for adjacent television lines of a television field (or frame). It is with this latter method of additional data transmission that the present invention is particularly concerned.

According to the present invention there is provided a television transmission system including means at a transmitter thereof and means at a receiver thereof for producing from the line synchronising pulses of the system respective clock waveforms of the same frequency as the television line frequency, together with means at the transmitter for producing binary coded data bits representing characters to be displayed at the receiver, and means under the control of the transmitter clock waveform for clocking these data bits into line blanking intervals in the television video signal, at a rate of only one data bit per television line, for transmission within the television video signal, means being provided at the receiver under the control of the receiver clock waveform for clocking the data bits out of the line blanking intervals for utilisation.

A television transmission system according to the invention has an advantage over prior systems in that by deriving the clock waveforms from the line synchronising pulses which are already present in the system, no special clock generators need be provided for producing these clock waveforms.

In a television transmission system according to the invention, the binary coded data bits can be inserted into line blanking intervals anywhere between the beginning of the line synchronising pulse and the start of the normal line information. The transmission of the data bits may be effected in any of several ways, for instance by means of bi-phasal pulses, or simple on/off pulses. It is also envisaged that the data bits may be transmitted by variation of the length of the colour burst, where available, that occurs in each line blanking interval of a television video colour signal; for instance, by making 8 cycles of the colour burst represent a '0' bit and 16 cycles represent a '1' bit. Another possibility is to use frequency pulses, for instance bursts of sinewave modulation, for transmitting the data bits. All or only some of the television lines of each television field (or frame) may be used for the transmission of the data bits in accordance with the invention.

A television transmission system according to the invention can achieve an average data bit rate of approximately 15 K. bits/sec. as applied to a 625 line broadcast television system.

In a television transmission system according to the invention, the characters represented by the transmitted data bits can be displayed at a receiver as a selectable alternative to the normal television picture information. Accordingly, a receiver for use in the system would include selection means for selecting for display either these characters or the normal television picture information, as chosen by a viewer. Alternatively, these characters may be superimposed on, and thus displayed with, the normal television picture information, or a special receiver which responds only to the data bits may be used to display only the characters which these data bits represent.

With regard to the first alternative mentioned, it is envisaged that this can be used for the display of captions anywhere on a television picture.

The transmission of data bits representing characters in a television transmission system according to the invention can be effected in conjunction with the transmission of additional data during field blanking intervals where the system is thus additionally equipped as in the case of the BBC—CEEFAX system, for example. Also, a television transmission system according to the invention can be a broadcast system or a closed-circuit system using a transmission line.

In order that the invention may be more fully understood, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 shows diagrammatically a television transmitter for a system according to the invention;

Figure 2 shows diagrammatically a television receiver for a system according to the invention;

Figure 3 shows a modification of Figure 2;

Figure 4 shows a waveform which is representative of a television video signal for one television line and includes a data bit pulse;

Figure 4*a* to 4*c* show respective other ways of transmitting data bits;

Figure 5 shows diagrammatically a television receiver, for a system according to the invention, arranged for caption display; and

Figure 6 shows diagrammatically a suitable transmission format for characters which form captions.

Referring to the drawings, the television transmitter shown in Figure 1 comprises an amplifier 1, a delay unit 2 and an AND-gate 3. A television video signal source of the television transmitter for producing the normal television video signal is represented at 4, an additional data source at 5 and a keyboard or other data selector means at 5^1. A television video signal to be transmitted is applied from source 4 to the amplifier 1 via a lead 6. The line synchronising pulses which are included in the television video signal are also applied from the source 4 to the delay unit 2 via a lead 7. The delayed synchronising pulses at an output lead 8 of the delay unit 2 constitute clock pulses which define a period within each line blanking interval of the television video signal. These clock pulses are applied to the data source 5 to clock-out data bits as selected by the data selector 5^1. These selected data bits are applied over a lead 9 to the AND-gate 3 where they are gated with the clock pulse output from the delay unit 2. The output from the AND-gate 3 is applied over a lead 10, which forms a summing junction with the lead 6, to the amplifier 1, so that it is inserted into the television video signal for transmission therewith, output lead 11 of the amplifier 1 being connected to an output stage 12 of the television transmitter.

The television receiver shown in Figure 2 comprises a comparator amplifier 13, an AND-gate 14 and a delay unit 15. The usual tuning and amplifying circuits and the video detector stage of the receiver are represented at 16, a data decoder is represented at 17, a data memory at 18 and a display screen of the receiver at 19. The video detector stage 16 is responsive in conventional manner to a received television video signal to produce signals for displaying the received television picture on the display screen 19, this display being selectable by a viewer by means of a selector switch S1. The received television video signal is also

applied from the stage 16 via a lead 20 to the comparator amplifier 13 which is responsive in accordance with the setting of a slider 21 to reproduce the signal at a corrected d.c. level, the output of the comparator 13 being connected to one input of the AND-gate 14. The line synchronising pulses detected from the received television video signal in stage 16 are also applied from this stage via a lead 22 to the delay unit 15. The resulting delayed synchronising pulses at an output lead 23 of the delay unit 15 constitute clock pulses which define a data period within each line blanking interval of the received television video signal. These clock pulses are applied to the other input of the gate 14 to clock the data bit inserted into each line blanking interval into the decoder 17 via a lead 24. The clock pulses from the delay unit 15 are also applied to the decoder 17 to clock-out the decoded data bits into the data memory 18 which is operable in a known manner to produce the display of the characters represented by the data bits on the display screen 19, this display also being selectable by a viewer by means of a selector switch S2. As indicated in broken line, a separate display device 19^1 may be provided solely for displaying these characters.

In the waveform shown in Figure 4, the line synchronising pulse for one television line is represented at 25, its leading edge being 26. The colour burst (when present) is represented at 27 and the normal line information at 28. The line blanking interval occupies the period $t1$. In accordance with the invention a data pulse 29 is inserted on the back porch of the line blanking interval between the end of the colour burst 27 and the beginning of the normal line information 28, but it could, of course, be inserted elsewhere in the line blanking interval. In the embodiment being described, the durations of the different periods within the period $t1$ are assumed to be as indicated in Figure 4. Thus, the pulse width of the data pulse 29 is 0.5 μ sec and is sampled 8.4 μ sec after the leading edge 26 of the line synchronising pulse 25. The data pulse is approximately 70% of the peak white level 30 and represents a data bit '1'. A data bit '0' is the block level. Data pulses may be inserted in each or only certain lines of each television field. Typically, for the embodiment described, data bit insertion starts on line 10 (323) and finishes in line 310 (623) giving a data bit rate of 300 bits/field or 15K bits per second.

Instead of using a simple on/off data pulse for the transmission of a data bit, transmission techniques as illustrated in Figure 4*a* to 4*c* may alternatively be employed. In Figure 4*a* a data pulse 29^1 is a bi-phasal pulse having a positive portion above the black level and a following negative portion below the black level. This pulse 29^1 represents a data bit '1', say. A data bit '0' is represented by a bi-phasal pulse 29^{11} having a negative portion below the black level and a following positive portion above the black level. In Figure 4*b*, a colour burst 27^1 of one length (e.g. 16 cycles) represents a data bit '1', say, and a colour burst 27^{11} of a different length (e.g. 8 cycles) represents a data bit '0'. In Figure 4*c*, a frequency pulse $df1$ of sinewave modulation represents a data bit '1', say, and a frequency pulse $df2$ of sinewave modulation, of different frequency, represents a data bit '0'. Alternatively, the absence of a frequency pulse can represent a data bit '0'. The or each frequency pulse can be of sufficient duration to be at least partially transmitted with the colour burst 27. For the transmission techniques according to Figures 4*b* and 4*c*, it will be apparent that in the television transmitter of Figure 1, an appropriate form of encoder is required at the output of AND-gate 3, while in the television receiver of Figure 2, an appropriate form of decoder is required at the data input of AND-gate 14.

Since, in a system according to the invention, the clock pulses for clocking out the data bits at the television receiver are derived from the synchronising pulses in the received television video signal, it is possible to extract the data bits as long as the received television picture itself remains in synchronisation. Instead of using the received synchronising pulses directly, these pulses may be used to drive a fly-wheel synchronising pulse geenrator which supplies pulses to the delay unit 15.

In cases of poor reception, it may be difficulty with the simple circuitry of Figure 2 to detect reliably the presence or the absence of the data pulse 29. This difficulty can be mitigated by using the modification shown in Figure 3. In this modification, the delayed synchronising (clock) pulses from the delay unit 15^1 are used to control an integrator 31 and associated electronic switches 32 and 33. During the period of each clock pulse, switch 32 is closed and switch 33 is opened so that the whole level of the back porch interval (or that portion between the end of the colour burst 27, when present, and the beginning of the normal line information 28) is integrated. Between each clock pulse, switch 32 is opened, and switch 33 is closed to apply the integration result to a comparator 34. Slider 35 is set to define a d.c. level relative to the integration levels for the presence and absence of a data pulse. Thus, even if a data pulse "spreads" due to poor reception it can still be detected by the integration.

The television receiver shown in Figure 5 is arranged specifically for caption dis-

play. In this receiver a data decoder and a data memory (as represented by elements 17 and 18 in Figure 2) are shown in greater detail than in the television receiver of Figure 2. Also, in the receiver of Figure 5, a data extractor element 36 corresponds to the elements 13, 14 and 15 in the receiver of Figure 2. Considering now the operation of the receiver of Figure 5, the received video signal *Vs* is fed to the stage 16 which supplies the picture information for displaying a television picture on the display screen 19. A synchronising pulse separator 37 separates the line and field synchronising pulses *Lp* and *Fp* from the received video signal *Vs*. The line synchronising pulses *Lp* are applied to the element 36 which in responsive thereto to feed out serially the data bits located in the line blanking intervals of the received video signals Vs. These data bits are fed serially into a series-to-parallel converter 38 which is interrogated by an address recognition circuit 39 in accordance with a required caption address fed to it from a caption selector 40 which is operated by a viewer. The parallel outputs of the converter 38 feed two caption rows stores 41 and 42 which, suitably, are 32×8 bit stores. The outputs from these two stores 41 and 42 are applied in common to a multiplexer 43, the outputs of which feed a character generator 44. A timing circuit 45 is responsive to the line and field sync. pulses *Lp* and *Fp* extracted from the incoming video signal by the extractor 37 to clock the elements 38, 39, 41, 42 and 43. The timing circuit 45 also clocks a row counter 46 and a shift register 47 to obtain character information from the character generator 44, this character information being fed serially from the register 47 over an output lead to the display screen 19. By suitably adjusting the timing circuit 45, the caption data can be displayed any where on the television picture.

Timing & Display location

A suitable transmission format for characters which form captions for display by the receiver of Figure 5 is as follows. The binary coded data bits are suitably in the conventional ASCII code with 8 bits per character. The caption display consists of two rows each of 32 characters, and a single two row caption is transmitted during two television fields. Each caption is updated every two seconds so that there is a choice of up to 50 different captions for a viewer. The transmission format is shown in Figure 6, from which it can be seen that during a field period F, between successive field synchronising pulses Fp, lines L20 and L284 are utilised for transmitting data bits. The data bits in the first seven lines L20—L26 identify the different captions, the daata bit in the line L27 identifies the caption row, and the data bits in the lines L28—L284 identify the 32 characters of a caption row.

WHAT WE CLAIM IS:—

1. A television transmission system including means at a transmitter thereof and means at a receiver thereof for producing from the line synchronising pulses of the system respective clock waveforms of the same frequency as the television line frequency, together with means at the transmitter for producing binary coded data bits representing characters to be displayed at the receiver, and means under the control of the transmitter clock waveform for clocking these data bits into line blanking intervals in the television video signal, at a rate of only one data bit per television line, for transmission within the television video signal, means being provided at the receiver under the control of the receiver clock waveform for clocking the data bits out of the line blanking intervals for utilisation.

2. A system as claimed in Claim 1, wherein the transmission of the data bits is by means of simple on/off transmission at black level or at a percentage of peak white level.

3. A system as claimed in Claim 1, wherein the transmission of the data bits is by means of bi-phasal transmission using one pulse having a portion below black level followed by a portion above black level and another pulse having a portion above black level followed by a portion below black level.

4. A system as claimed in Claim 1, wherein the transmission of the data bits is by variation of the length of the colour burst, where available, that occurs in each line blanking interval of a television video colour signal, a colour burst of one length representing a '0' data bit and a colour burst of different length representing a '1' data bit.

5. A system as claimed in Claim 1, wherein the transmission of the data bits is by means of frequency pulses.

6. A system as claimed in Claim 5, wherein said frequency pulses are bursts of sinewave modulation.

7. A system as claimed in Claim 2, wherein at a receiver, means are provided for integrating the whole level of the back porch interval to determine the presence or absence of a data bit in dependence on the integrated level produced.

8. A system as claimed in Claim 2 arranged for colour transmission, wherein at a receiver, means are provided for integrating the whole level of the back porch between the end of the colour burst and the beginning of the normal line information to determine the presence or absence of a data bit in dependence on the integrated level produced.

9. A system as claimed in any preceding Claim, wherein at a receiver, means are provided for selecting for display either the characters represented by the transmitted binary coded data bits or the normal television picture information.

10. A system as claimed in any one of Claims 1 to 8, wherein at a receiver, means are provided for superimposing the characters represented by the transmitted binary coded data bits onto the normal television picture for display therewith.

11. A system as claimed in Claim 10, wherein said characters form captions, and means are provided for displaying these captions anywhere on a television picture.

12. A receiver of a television transmission system according to any preceding Claim.

13. A transmitter of a television transmission system according to any one of Claims 1 to 11.

14. In or for a television transmission system as claimed in Claim 1, a transmitter substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

15. In or for a television transmission system as claimed in Claim 1, a receiver substantially as hereinbefore described with reference to Figure 2 or Figure 3 or Figures 5 and 6 of the accompanying drawings.

16. A television transmitter according to Claim 14 adapted for operation with binary coded data bits which are transmitted substantially as hereinbefore described with reference to Figures 4 or 4*a* or 4*b* or 4*c* of the accompanying drawings.

17. A television receiver according to Claim 15, adapted for operation with binary coded data bits which are transmitted substantially as hereinbefore described with reference to Figure 4 or 4*a* or 4*b* or 4*c* of the accompanying drawings.

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1486424 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

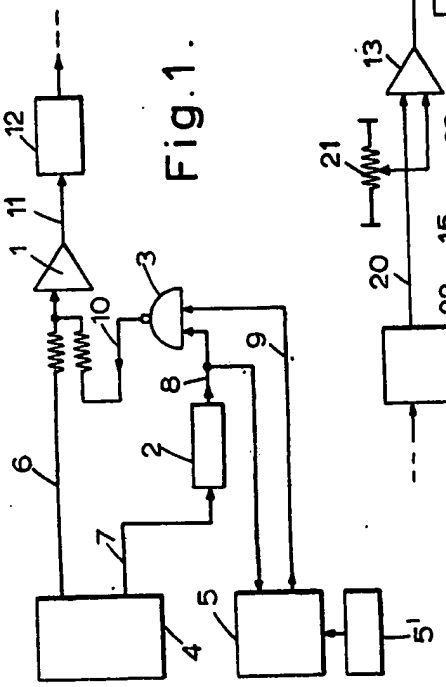


Fig.1.

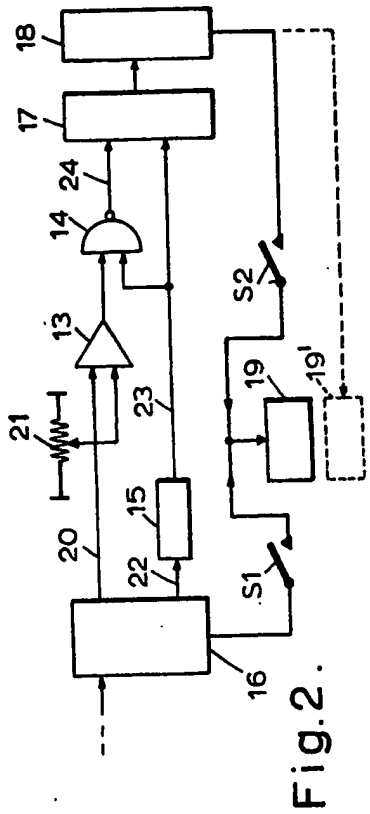


Fig.2.

1486424 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

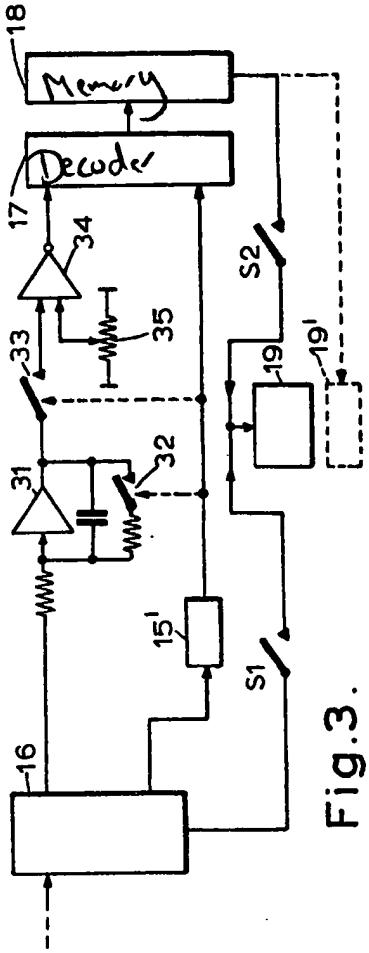


Fig.3.

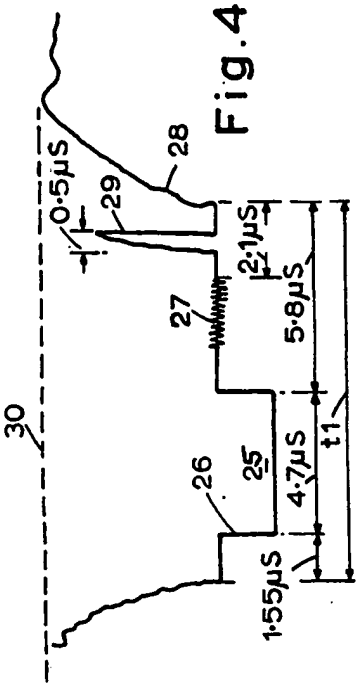


Fig.4.

1486424 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

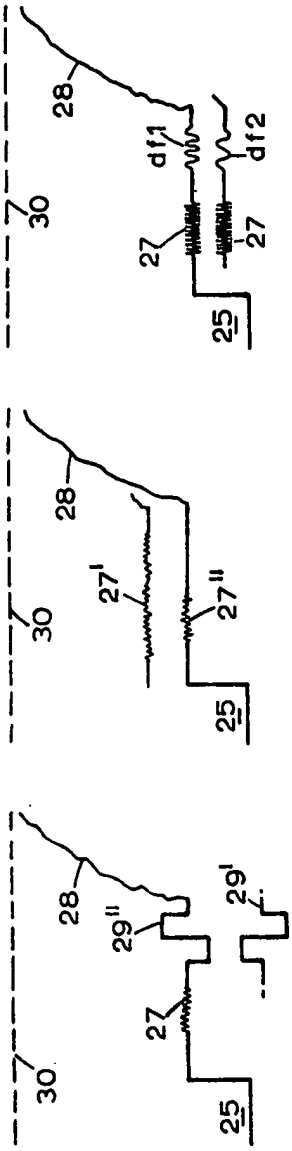


Fig.4c.

Fig.4b.

Fig.4a.

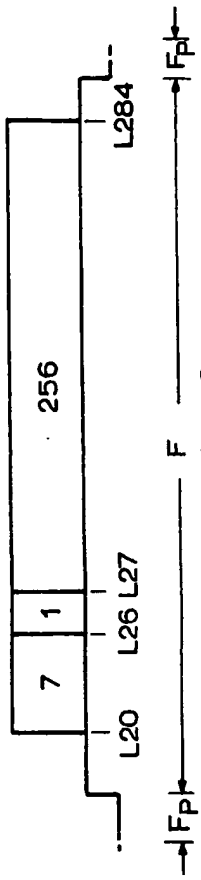
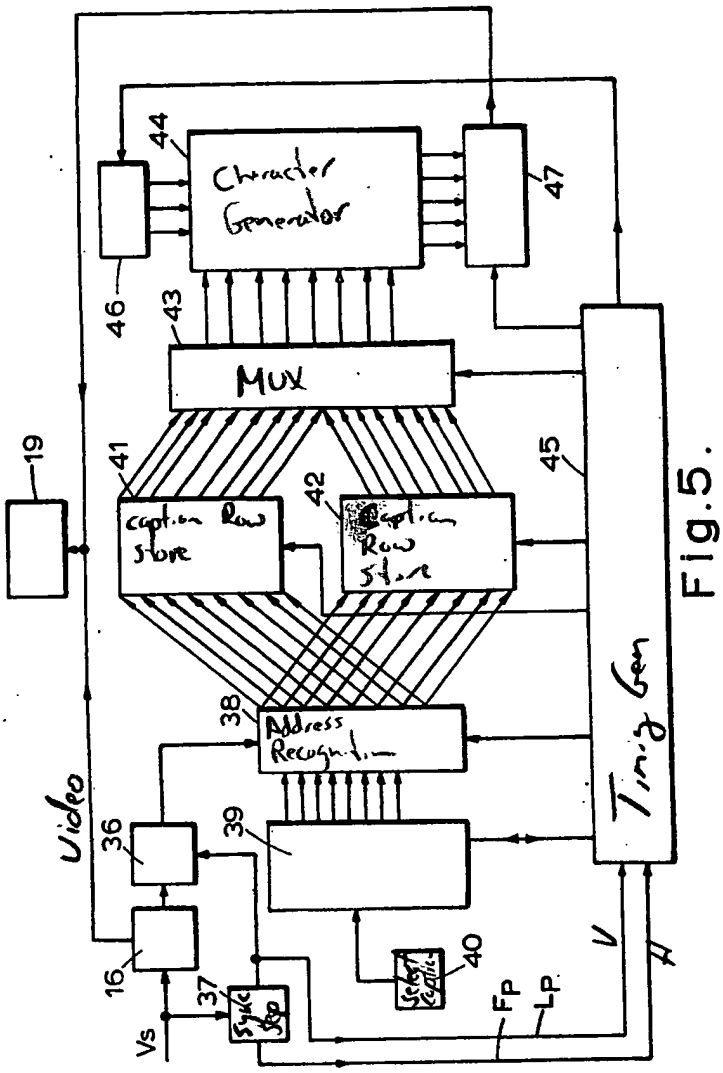


Fig.6.


Character Generator
MUX
caption Row store
Caption Row store
Address Recognition
Timing Gen
Video
Sync Sep
Select Control
Vs
Fp
Lp
V
H
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16

Fig.5.